

Name: _____

Chemistry 129.03 Spring 2011

General Chemistry

Examination #3:

Equations are provided.

You may use a calculator.

Show all your work!

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Bonus: _____/2

Total: _____/100

1. (a) Classify the following salts as basic, acidic or neutral. (6 pts.)

(i) KCl _____

(ii) NH_4NO_3 _____

(iii) NaHSO_3 _____

(iv) $\text{Ba}(\text{C}_2\text{H}_3\text{O}_2)_2$ _____

(v) $\text{Fe}(\text{ClO}_4)_3$ _____

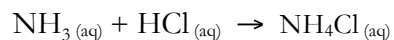
(vi) Na_2CO_3 _____

- (b) Rank the following acids in order of increasing strength. Explain. (6 pts)

HClO_2 , HClO_4 , HClO , HClO_3

2. (6 pts.) A 1.0 L buffer solution that is 0.125 M $\text{HC}_2\text{H}_3\text{O}_2$ ($K_a = 1.8 \times 10^{-5}$) and 0.100 M in $\text{NaC}_2\text{H}_3\text{O}_2$ has a pH of 4.65. What is the pH of the buffer solution after 0.030 mol of HCl have been added?

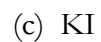
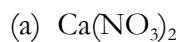
3. (16 pts) Consider the titration of 15.00mL of 0.200 M ammonia (NH_3), $K_b = 1.8 \times 10^{-5}$, with 0.100 M HCl:



Determine:

- (a) the $[\text{OH}^-]$ and the initial pH of the ammonia solution (6 pts.)
- (b) the $[\text{H}_3\text{O}^+]$ and pH after the addition of 30.00mL of HCl. What point in the titration is this? Does the pH value make sense? Why? (10 pts.)

4. An ammonia (NH_3) solution has a pH of 11.13. Which of the following substances will decrease the pH of the solution upon addition? (4 pts)



5. (12 pts) A gas is confined to a cylinder under constant atmospheric pressure. When 378 J of heat are absorbed by the gas it expands and does 56 J of work on the surroundings.

- (a) What is the change in the internal energy of the system? What is the change in the internal energy of the surroundings? (6 pts)

- (b) What is the change in the enthalpy? Why? (3 pts)

- (c) Is the process endothermic or exothermic? Why? (3 pts)

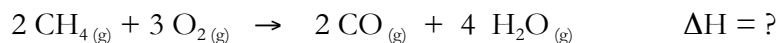
6. (a) (3 pts) The same quantity of heat is added to 10.00 g of gold, 10.00 g of iron, and 10.00 g of copper, all initially at 25 °C. The specific heats of these metals are:

$$Au = 0.125 \frac{J}{g \text{ } ^\circ C} \quad Fe = 0.460 \frac{J}{g \text{ } ^\circ C} \quad Cu = 0.397 \frac{J}{g \text{ } ^\circ C} \quad (3 \text{ pts})$$

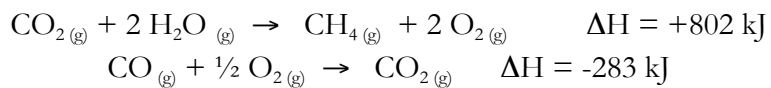
Which piece of metal has the highest final temperature? Why?

- (b) (5 pts) Calculate the final temperature of 10.00 g of this metal after 100.0 J of heat have been added.

7. (9 pts) Calculate ΔH_{rxn} for the reaction :



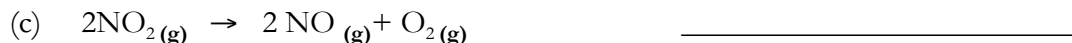
given the following set of reactions and their respective enthalpy changes:



8. (5 pts) Without doing any calculations, predict whether ΔS is positive, negative for each of the following processes, assuming each occurs at constant temperature:



(b) Hot air expanding _____



(d) Dew forming _____



9. (4 pts) When a system is at equilibrium,
- the reverse process is spontaneous, but the forward process is not.
 - the forward and reverse processes are both spontaneous.
 - the forward process is spontaneous, but the reverse process is not.
 - the process is not spontaneous in either direction.

10. (16 pts) Consider the following reaction:



	$\text{H}_2\text{SO}_{4(\text{l})}$	$\text{SO}_{3(\text{g})}$	$\text{H}_2\text{O}_{(\text{l})}$
S° (J/mol.K)	+156.90	+256.66	+69.94
ΔH_f° (kJ/mol)	-814.0	-396.0	-285.84

- (a) Calculate ΔS° for the reaction using the given S° values. **Explain the sign of ΔS° .** (6 pts)

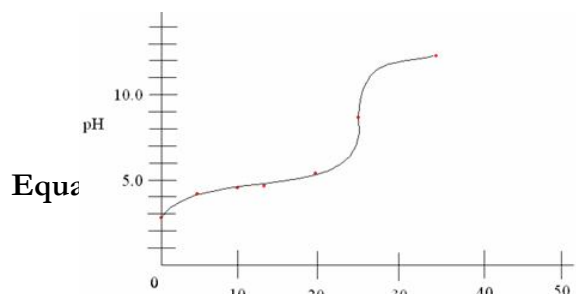
- (b) Determine ΔH° for the reaction. **Explain the sign of ΔH° .** (6 pts)

(c) Calculate ΔG° for the reaction. Is the reaction spontaneous, as written, at 298K? Why? (6 pts)

(d) Determine the equilibrium constant at 298K. What reaction is favored (forward or reverse)? Why? (6 pts)

Bonus:

This figure shows the titration curve of a weak acid. Show (label) the equivalence point of the titration and the buffer region in the graph. (2pts)



$$pH = -\log[H_3O^+]$$

$$pOH = -\log[OH^-]$$

$$pH + pOH = 14.00$$

$$[H_3O^+] = 10^{-pH}$$

$$[OH^-] = 10^{-pOH}$$

$$[H_3O^+][OH^-] = 1.0 \times 10^{-14}$$

$$K_a \times K_b = K_w$$

$$pK_a = -\log[K_a]$$

$$pK_b = -\log[K_b]$$

$$pK_a + pK_b = 14.00$$

$$[H_3O^+] = \sqrt{K_a \times [acid]}$$

$$pH = pK_a + \log\left(\frac{[base]}{[acid]}\right)$$

$$[OH^-] = \sqrt{K_b \times [base]}$$

$$K_w = 1.0 \times 10^{-14}$$

$$K = ^\circ C + 273.15$$

$$\Delta E = q + w$$

$$w = -P\Delta V$$

$$\Delta V = V_{final} - V_{initial}$$

$$q = m \times C_s \times \Delta T$$

$$\Delta T = T_{final} - T_{initial}$$

$$\Delta S_{Rxn}^\circ = \sum n S^\circ_{(prod)} - \sum m S^\circ_{(react)}$$

$$\Delta H_{Rxn}^\circ = \sum n H_f^\circ_{(prod)} - \sum m H_f^\circ_{(react)}$$

$$\Delta S^\circ_{surr} = \frac{-\Delta H^\circ_{sys}}{T}$$

$$\Delta S^\circ_{univ} = \Delta S^\circ_{sys} + \Delta S^\circ_{surr}$$

$$\Delta G_{Rxn}^\circ = \sum n G_f^\circ_{(prod)} - \sum m G_f^\circ_{(react)}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\Delta G^\circ = -RT \ln K$$

$$K = e^{-\left(\frac{\Delta G^\circ}{RT}\right)}$$

Constants and Conversion Factors

$$1 \text{ L}\cdot\text{atm} = 101.3 \text{ J}$$

$$R = 8.314 \times 10^{-3} \text{ kJ/mol}\cdot\text{K}$$